COGNITIVE

ESC Sensing Node

Presentation to FCC in Partnership with KeyBridge LCC

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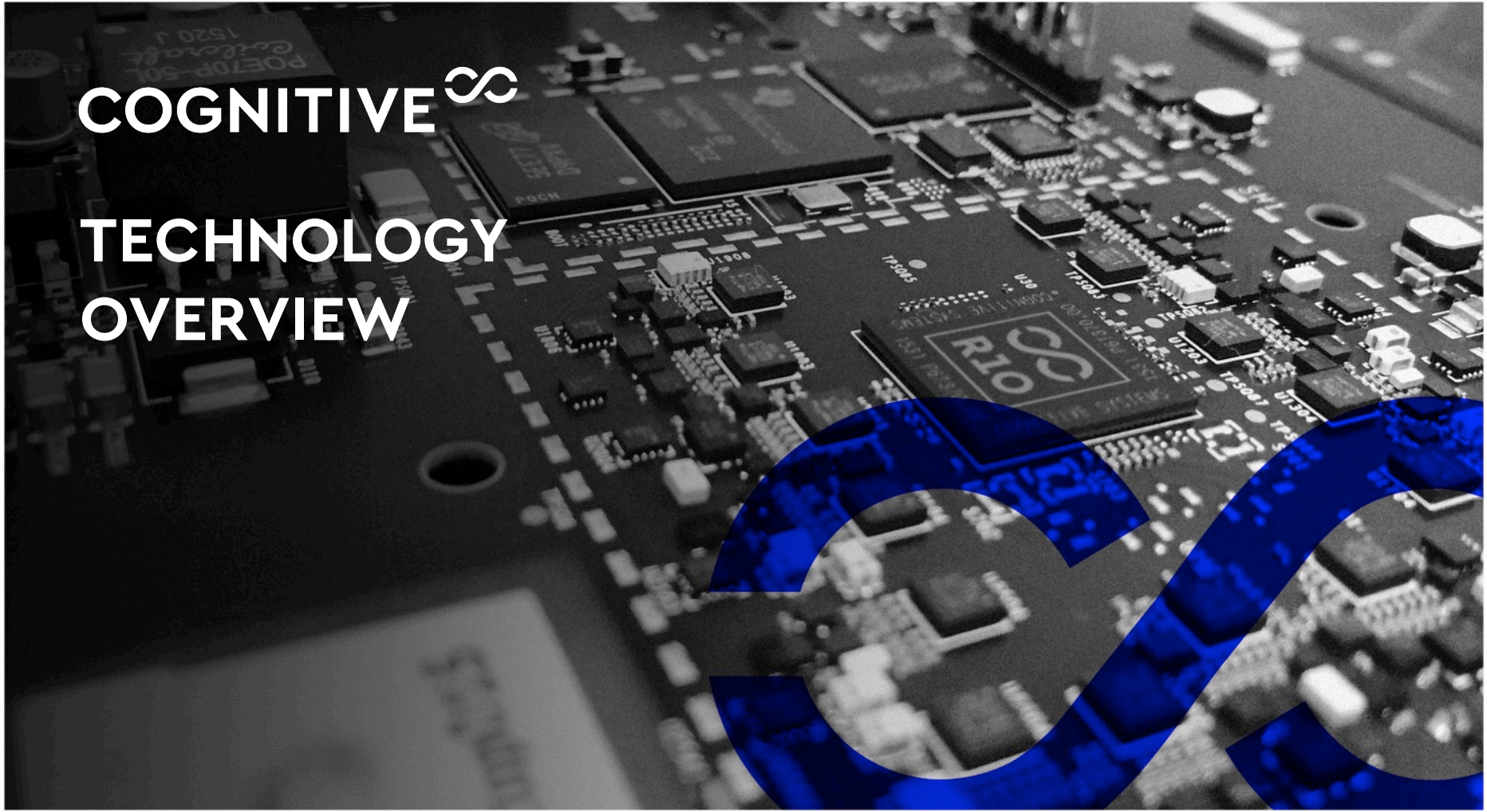
COGNITIVE
TECHNOLOGY
OVERVIEW

THE PLATFORM

The cognitive radio system is built to enable solutions for wireless applications. Each component, from the chipset to the interface, plays a vital role in delivering the data required to change the way wireless signals are processed and used.

COGNITIVE RADIO CHIP SET

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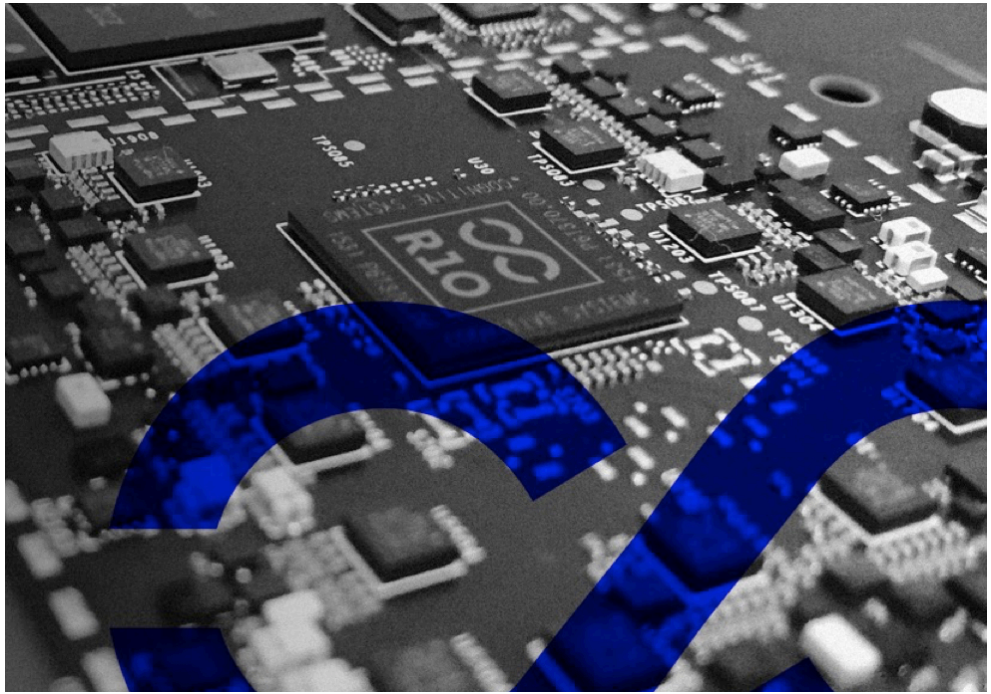

- 40nm CMOS TSMC LP Production Process
- Radio enables:
  - Frequency coverage: 0.65 GHz – 4.0 GHz
  - 4x receivers (2x receivers with diversity, and 2 independent radios) Single receiver analog bandwidth: up to 40 MHz
  - Radio self calibration/testing in the field
  - System NF ~5dB (includes 3dB of front end losses)
  - 11 bit ADC 52MHz BW
  - Analog programmable baseband BW 200kHz to 20MHz
  - 80dB of controllable gain
- R10 digital & toolbox firmware:
  - Dual flexible vector process
  - FEC processing
  - Internal CPU
- R10 toolbox firmware:
  - PHY/MAC's: 3G, LTE, A-LTE, WiFi, BT, others
  - Motion detection using Wireless Signal
  - Spectrum Analysis Toolbox
  - Radar detection
  - CyberSecurity

EXAMPLE: FIRMWARE FOR SMART SCAN

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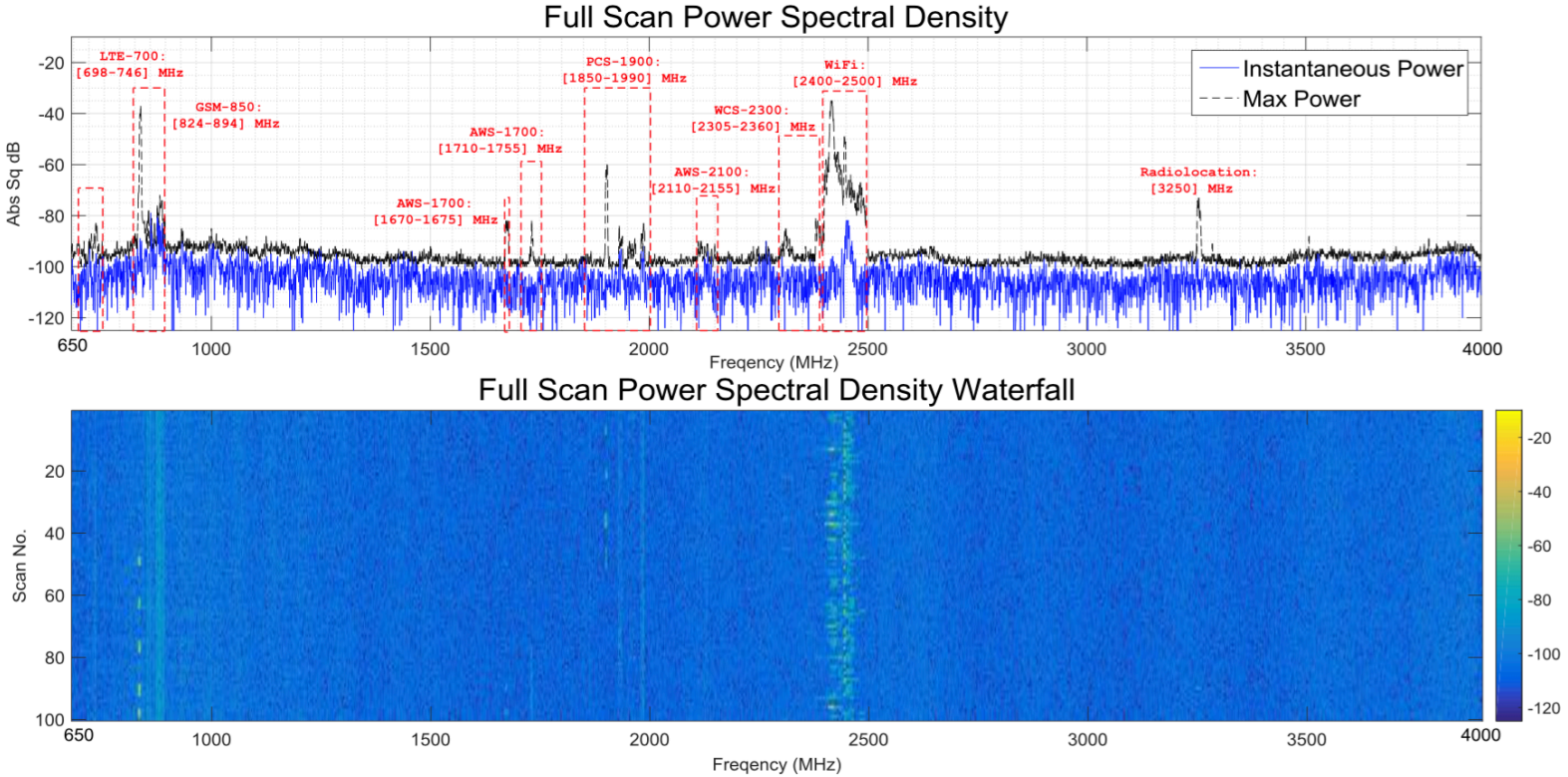

EXAMPLE: FIRMWARE FOR PLMN SCAN OF ALL CELLULAR

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PLMN Scan

Cell ID	Frequency (MHz)	RSSI (Main)
133	723.00	-91.51
309	723.00	-91.51
321	723.00	-91.51
333	723.00	-91.51
39	723.30	-90.96
103	737.00	-83.14
396	737.00	-83.14
247	1960.00	-86.69
309	1960.00	-86.69
321	1960.00	-86.69
333	1960.00	-86.69
397	1960.00	-86.69
100	1960.50	-91.56
63	2117.50	-92.41
198	2147.50	-92.92
247	2147.50	-92.92
279	2147.50	-92.92
397	2147.50	-92.92
43	2629.70	-102.06
247	2630.00	-102.45
321	2630.00	-102.45
225	2649.40	-82.03
63	2650.00	-100.34
432	2650.50	-100.11

MIB

Cell ID	Frequency (MHz)	NTX	RSRQ	NDLRB	RSRP	SNR
396	737.00	2	-16.00	25	-103.97	17.23
247	2147.50	2	-14.14	75	-103.26	17.94
247	2630.00	2	-8.77	100	-112.47	8.73

SIB

Cell ID	Frequency (MHz)	MCC	MNC	NTX	RSRQ	NDLRB	RSRP	SNR
247	1960.00	302	610	2	-10.71	100	-101.34	19.86
63	2117.50	302	720	2	-13.98	75	-98.55	22.64
63	2650.00	302	720	2	-8.52	100	-108.41	12.79

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SPECTRUM ANALYTICS

SPECTRUM ANALYTICS

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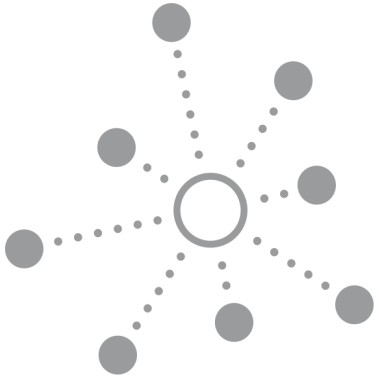
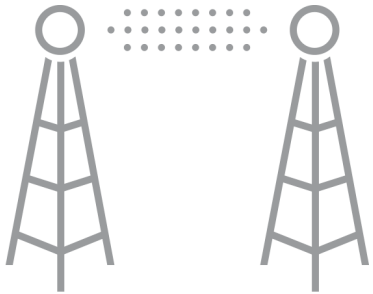


SPECTRUM SHARING

Enable spectrum sharing with sensors that can monitor a customizable number of bands for incumbent use, and connect with an administrator system to ensure dynamic allocation.



SPECTRUM DEVELOPMENT

Create network infrastructure plans based upon accurate data regarding existing network performance, and ensure seamless coverage and optimal capacity with minimal spend.

SPECTRUM INSPECTION

Take a proactive approach to managing spectrum by receiving up-to-date, in-depth data regarding the health of the network, including congestion, performance, interference, and jamming.

ESC Sensor node

W= 224mm **H= 100mm** **L= 200mm**

Sealed weather-proof housing
(IP67 compliant)

Standard bolt template for flexible mounting to various fixtures such as poles, walls, etc. Specific brackets required for each mounting application. Tamper-resistant bolt heads.

RADIO SPECIFICATION

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Radio

Operating Frequency	680MHz to 4GHz
Radio Configuration	4 Receivers/1Transmitter Independent local oscillators for TX and RX 2 Independent frequency-synchronized diversity re-ceivers (independent local oscillators per RX
Channel Bandwidth	200 KHz to 40MHz per receiver
Supported RF Bands	27 most used 3GPP bands 3 wide bands (no SAW filters) 2.4G/915M ISM bands
Receiver Maximum Input Power	Up to -5dbm in band/0dbm out of band
Sampling Rate	Maximum 104Msps (11 bits ADC)

RADIO SPECIFICATION - Continued

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Radio Continued

Receiver Maximum Input Power	Up to -5dbm in band/0dbm out of band
Sampling Rate	Maximum 104Msps (11 bits ADC)
Transmitter	Cognitive transmitter at 2.4GHz ISM band (104Msps, 12 bits DAC, +15dbm max output power)
Supported Radio Protocols (Rx)	4G/LTE 3G/WCDMA Wi-Fi (802.11b/g/n) Bluetooth SPN-43 radar detector Other protocols under consideration
Location/GNSS	GPS+GLONASS
Digital Processing	8 IQ data channels(filtering, resampling, impairments compensation) 2 cores CSC proprietary control MCU 2 cores CSC proprietary VLIW/SIMD DSP ARM Cortex A8 host/networking MCU 512MB DDR3 SRAM 4GB eMMC flash memory

RADIO PORTS AND SECURITY

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Legend

- N-type female connectors for external antennas with lightning protection
- RJ45 connector for network and Power-over-Ethernet
- N-type female connector for GPS antenna with lightning protection
- M4 grounding connection
- M8 mounting bolt holes (4)
- Pressure vent

Communications

Network Interface	100 Base-T Ethernet over shielded RJ5 (with PoE) TCP/IP (DHCP configurable) Wi-Fi 802.11a/b/g/n, 2.4/5.8 GHz (optional)
Data Interface	Cloud-based RESTful API
Authentication	Hardware PKI (public/private keys) crypto-authentication engine (FIPS186-3 Elliptic Curve cyptography), 256 bit keys, TLS/HTTPS data transport

ESC ARCHITECTURE

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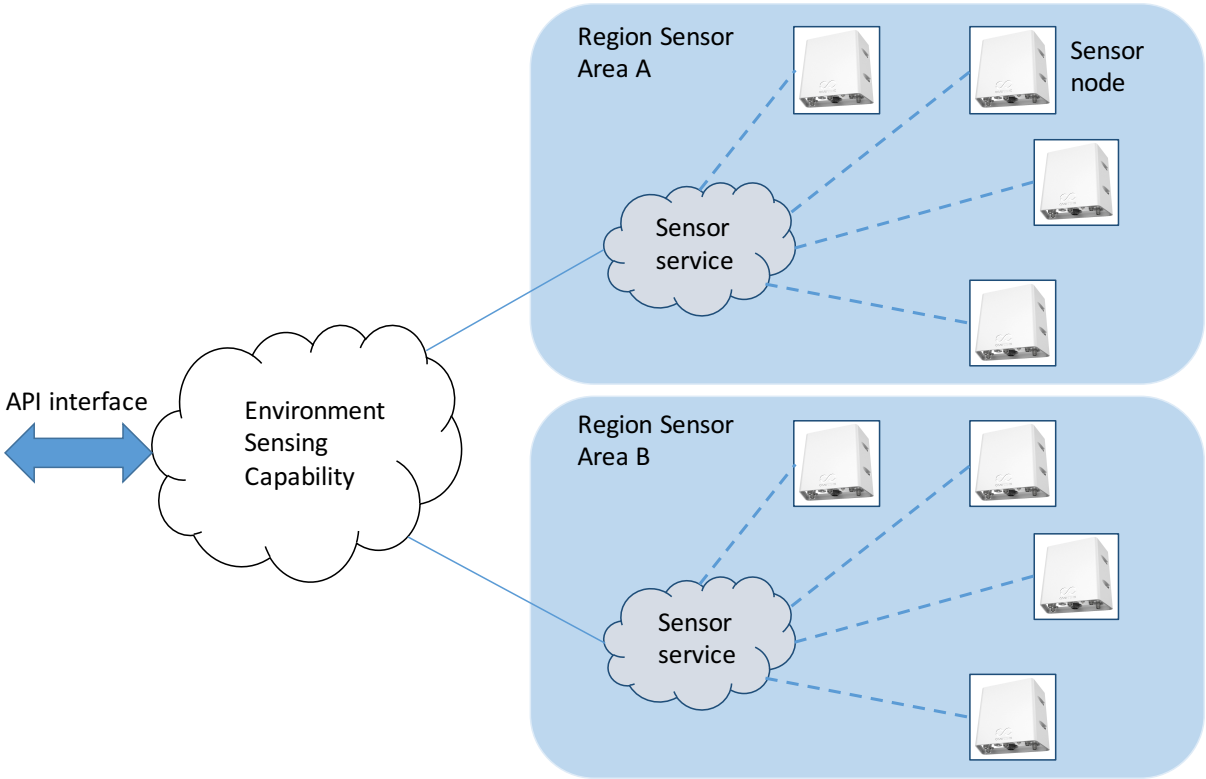

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RADAR DETECTION

RADAR MODEL AND DETECTOR R10 FIRMWARE SPECIFICATION

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Incumbent Characteristics	
Incumbent	SPN-43 Air Traffic Control Radar
Frequency Range (MHz)	3500 - 3650
Gain (dBi)	32
Power (kW)	850 +/- 150
Eff Output (dBm)	122
Pulse Interval (us)	889 +/- 20
Pulse Width (us)	0.9 +/- 0.15
Rotation Period (s)	4

Detectors Specification	
Frequency Scan Range (MHz)	3500 - 3650
Trigger Sensitivity (dBm)	-64
Instantaneous Bandwidth (MHz)	30
Temporal Feature Validation	Pulse Width, Pulse Interval
Temporal Feature Resolution (ns)	62.5
False Positive Rate (%)	0.00%
Detection Rate in Presence of CBSD (%)	98.40%

RADAR DETECTIONS FLOW – IMPLEMENTED IN R10

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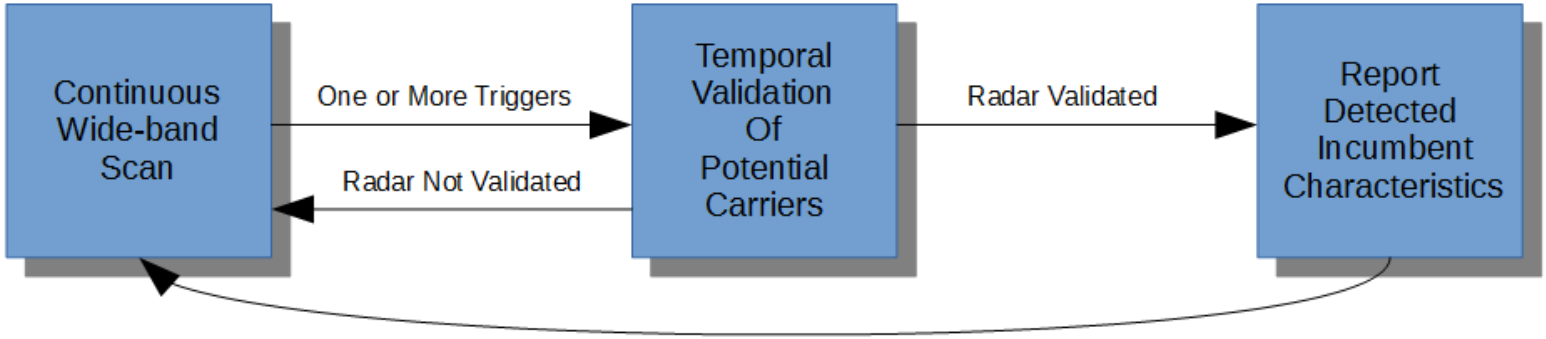

EXAMPLE: RADAR DETECTION

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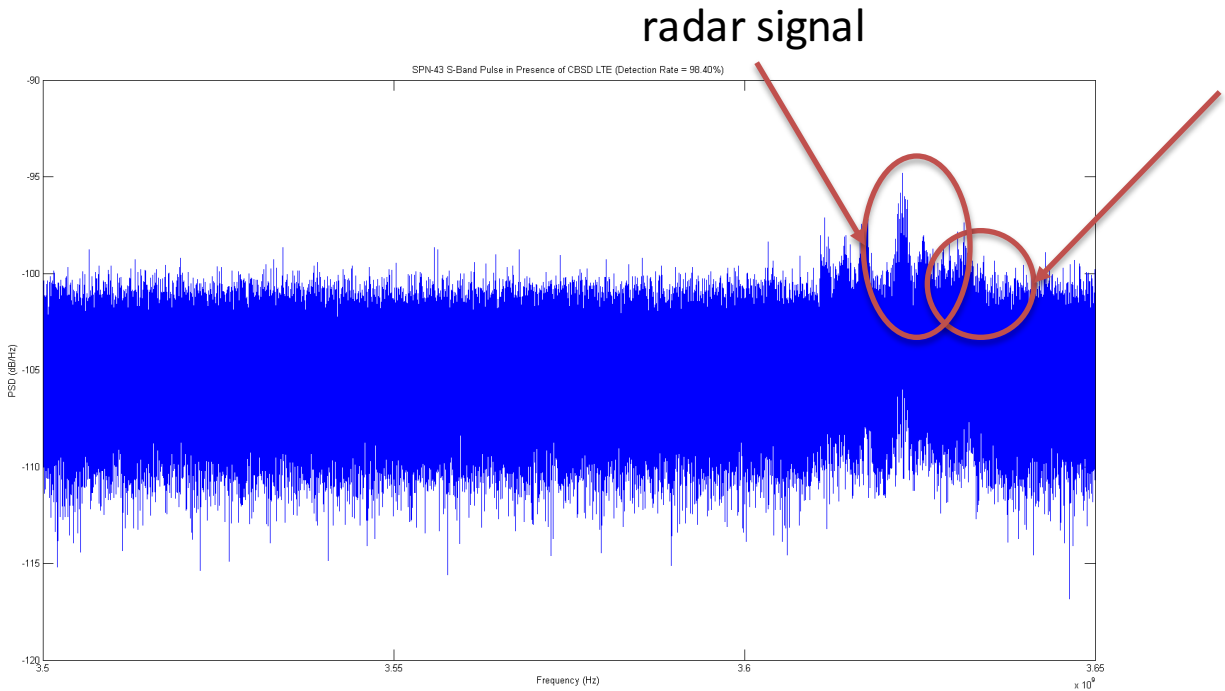

Simulation Setup:

-SPN-43 Radar emitting power of 122 dBm/1MHz is placed 80 km from the ESC and the signal travels through an 8-delay Rayleigh fading channel

-LTE CBSD is transmitting at 47 dBm/10MHz with a bandwidth of 20 MHz 10 m away from the ESC

-Both signals travel on the same carrier

Q&A